

Application Serial No. 10/674,970
Amendment dated March 7, 2005
Reply to Office Action dated December 13, 2004

This listing of claims will replace all prior versions, and listings, of claims in the application:

Listing of Claims:

Claim 1 (Original): An engine control system for a small internal combustion engine, comprising:

a governor assembly mounted to and driven by the engine and responsive to engine speed;

a coupling member associated with said governor assembly, said coupling member displaceable by said governor assembly according to engine speed; and

a position sensor associated with said coupling member, said position sensor detecting the displacement of said coupling member and outputting an electrical speed signal corresponding to the displacement of said coupling member and to engine speed.

Claim 2 (Original): The engine control system of claim 1, wherein said coupling member includes a rotary shaft rotationally displaceable by said governor assembly.

Claim 3 (Original): The engine control system of claim 2, wherein said position sensor includes a rotary sensor.

Claim 4 (Original): The engine control system of claim 2, wherein said position sensor includes a potentiometer.

Claim 5 (Original): The engine control system of claim 2, wherein:

said governor assembly includes a spool and at least one flyweight, said at least one flyweight capable of translating said spool laterally according to the engine speed; and

said rotary shaft includes a radially extending lever adjacent one end of said rotary shaft and contacting an end of said spool, wherein lateral movement of said spool rotationally displaces said rotary shaft.

Claim 6 (Original): The engine control system of claim 2, further comprising a spring coupled between said engine and said rotary shaft, said spring biasing said rotary shaft against said rotational displacement.

Claim 7 (Original): The engine control system of claim 1, further comprising:
an operator engine control producing an electrical command signal; and
a control circuit capable of determining an engine speed control signal based on said command signal and said speed signal.

Claim 8 (Original): The engine control system of claim 7, wherein said control circuit determines said engine speed control signal as a portion of said command signal, said portion based on actual engine speed sensed by said position sensor.

Claim 9 (Original): The engine control system of claim 8, wherein said position sensor includes a potentiometer having an input and a variable output, said command signal being coupled to said input and said engine speed control signal is provided by said variable output.

Claim 10 (Original): The engine control system of claim 7, wherein said engine speed control signal is the sum of said command signal and said speed signal.

Claim 11 (Original): The engine control system of claim 7, further comprising a fuel control device receiving said engine speed control signal.

Claim 12 (Original): The engine control system of claim 7, further comprising an electromechanical throttle actuator receiving said engine control signal.

Claim 13 (Original): The engine control system of claim 12, further comprising a fuel control device, and wherein said control circuit further comprises:
at least one of an intake air sensor and an exhaust gas temperature sensor; and
a fuel control signal determined as a function of the output of said at least one of said intake air sensor and said exhaust gas temperature sensor, said fuel injector control signal controlling said fuel control device.

Claim 14 (Original): The engine control system of claim 13, wherein said intake air sensor senses at least one of intake air temperature, cylinder head temperature, and intake mass airflow.

Claim 15 (Currently amended): ~~A small~~ An internal combustion engine, comprising:
an engine housing;
at least one of a throttle and a fuel control device connected to said housing;
a governor assembly connected to said housing and responsive to engine speed;
a coupling member coupled to said governor assembly and movably displaced by said governor assembly in response to engine speed; and
a position sensor mounted to said housing and adapted for detecting the position of said coupling member and outputting an electrical speed signal, said speed signal acting upon at least one of said throttle and said fuel control device to adjust the engine speed.

Claim 16 (Original): The internal combustion engine of claim 15, wherein said coupling member is rotationally displaced by said governor assembly in response to the engine speed and said position sensor is a rotary position sensor.

Claim 17 (Original): The internal combustion engine of claim 16, further comprising a spring biasing said rotary shaft against said rotational displacement.

Claim 18 (Original): The internal combustion engine of claim 15, further comprising:
at least one of an intake temperature sensor and an exhaust gas temperature sensor;
and
a fuel control signal determined as a function of the output of said at least one of said fuel intake air sensor and said exhaust gas temperature sensor, said fuel control signal controlling said fuel control device.

Claim 19 (Original): The internal combustion engine of claim 18, wherein said intake air sensor senses at least one of intake air temperature, cylinder head temperature, and intake mass airflow sensor.

Claim 20 (Original): An engine control system for a small internal combustion engine, comprising:

- a governor assembly driven by the engine, said governor assembly including a spool capable of translating axially in response to the engine speed;

- a rotary shaft associated with said spool such that said rotary shaft is rotationally displaced upon translation of said spool;

- a spring coupled between the engine and said rotary shaft, said spring resisting rotational displacement of said rotary shaft; and

- a rotary position sensor capable of detecting the rotational position of said rotary shaft and outputting an electrical speed signal corresponding to the rotational position.

Claim 21 (Original): The engine control system of claim 20, further comprising an operator engine control capable of producing an electrical command signal, and an engine speed control signal determined as a function of said command signal and said speed signal, said engine speed control signal supplied to at least one of a fuel control device and an electromechanical throttle actuator.

Claim 22 (Original): The engine control mechanism of claim 21, further comprising at least one of an intake sensor and an exhaust gas temperature sensor, and a fuel control signal determined as a function of the output of said at least one of said intake sensor and said exhaust gas temperature sensor outputs.

Claim 23 (Currently amended): A method of controlling the speed of an internal combustion engine having a mechanical governor, throttle, and fuel injector, comprising the steps of:

- supplying a commanded engine speed signal;

- driving the governor to produce an output proportional to engine speed;

- sensing the governor output;

- ~~determining~~ producing an actual engine speed signal from the governor output; and

- controlling the throttle based on the actual engine speed signal and the commanded engine speed signal.

Claim 24 (Original): The method of claim 23, comprising the further steps of:

- sensing the intake temperature;
- sensing at least one of the exhaust gas temperature and the intake mass airflow; and
- controlling fuel flow through the fuel injector based on the intake temperature and the at least one of the exhaust gas temperature and the intake mass airflow.

Claim 25 (Original): The method of claim 23, comprising the further steps of:

- sensing at least one of the intake air temperature and intake mass airflow;
- sensing the engine cylinder head temperature; and
- controlling fuel flow through the fuel injector based on the engine cylinder head temperature and the at least one of the intake air temperature and intake mass airflow.

Claim 26 (Currently amended): An engine control circuit [[for a small]] in an internal combustion engine including a mechanical speed sensing governor, the circuit comprising:

- at least one of a voltage supply and a current supply;
- a governor sensor coupled to said governor and having an input and an output, said governor sensor input coupled to said at least one of a voltage supply and current supply;
- an operator control sensor having an input and an output, said operator control sensor input coupled to said governor sensor output; and
- at least one of an intake throttle actuator and a fuel control device coupled to ~~at least one of said operator control sensor input and~~ said operator control sensor output.

Claim 27 (Original): The engine control circuit of claim 26, further comprising:

- an exhaust gas temperature sensor having an input and an output, said exhaust gas temperature sensor input coupled to said at least one of a voltage supply and a current supply;
- an intake temperature sensor having an input and an output, said intake temperature sensor input coupled to said at least one of a voltage supply and a current supply; and
- a fuel control device having an input coupled to said exhaust gas temperature sensor output and to said intake temperature sensor output.

Claim 28 (Currently amended): The engine control circuit of claim 26, further comprising:
an intake airflow sensor having an input and an output, said intake airflow sensor input coupled to said at least one of a voltage supply and a current supply;
an intake temperature sensor having an input and an output, said intake temperature input coupled to said at least one of a voltage supply and a current supply; and
a fuel control device having an input coupled to said ~~exhaust gas temperature~~ intake airflow sensor output and to said intake temperature sensor output.

Claim 29 (Currently amended): An engine control circuit [[for a small]] in an internal combustion engine including a mechanical speed sensing governor, the circuit comprising:
at least one of a voltage supply and a current supply;
an operator control sensor having an input and an output, said operator control sensor input coupled with said at least one of a voltage supply and a current supply;
a governor sensor coupled to said governor and having an input and an output, said governor sensor input coupled to said operator control sensor output; and
at least one of an intake throttle actuator and a fuel control device coupled to said governor sensor output.

Claim 30 (Original): The engine control circuit of claim 29, further comprising:
an exhaust gas temperature sensor having an input and an output, said exhaust gas temperature sensor input coupled to said at least one of a voltage supply and a current supply;
an intake temperature sensor having an input and an output, said intake temperature sensor input coupled to said at least one of a voltage supply and a current supply; and
a fuel control device having an input coupled to said exhaust gas temperature sensor output and to said intake temperature sensor output.

Claim 31 (Currently amended): The engine control circuit of claim 29, further comprising:
an intake airflow sensor having an input and an output, said intake airflow sensor input coupled to said at least one of a voltage supply and a current supply;
an intake temperature sensor having an input and an output, said intake temperature input coupled to said at least one of a voltage supply and a current supply; and

a fuel control device having an input coupled to said ~~exhaust gas temperature~~ intake airflow sensor output and to said intake temperature sensor output.

Claim 32 (Currently amended): An engine control system [[for a small]] in an internal combustion engine including a mechanical speed sensing governor, the system comprising:

an operator control sensor providing a command signal proportional to the desired engine speed;

an engine speed sensor coupled to said governor and providing a speed signal proportional to the actual engine speed;

a control circuit receiving said command signal and said speed signal and providing a fuel control signal determined as a function of said command signal and said speed signal;
and

a fuel control device having an actuator adapted for adjusting the fuel flow through said fuel control device, said actuator receiving said fuel control signal.

Claim 33 (Original): The engine control system of claim 32, further comprising:

a governor assembly mounted to and driven by the engine, said governor assembly responsive to the engine speed; and

a coupling member associated with said governor assembly, said coupling member displaced flow by said governor assembly according to the engine speed;

wherein said engine speed sensor senses the displacement of said coupling member.

Claim 34 (Original): The engine control system of claim 33, wherein said fuel control device comprises a variable speed fuel pump motor, said pump motor driven by said fuel control signal.

Claim 35 (Original): The engine control system of claim 33, wherein said fuel control device comprises a solenoid controlled variable fuel pressure regulator, said solenoid driven by said fuel control signal.

Claim 36 (Original): The engine control system of claim 35, further comprising a fuel system including a fuel source tank and a fuel pump driven by a fixed speed motor, and wherein said

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fuel pressure regulator is coupled in parallel with said fuel pump, thereby returning a variable fuel flow to said fuel source tank.

Claim 37 (Original): The engine control system of claim 34, further comprising a fuel system including a fuel pump driven by said variable speed fuel pump and a fixed restricting orifice coupled in parallel with said fuel pump.

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Replacement Abstract

Please replace the Abstract currently on file with the following:

ABSTRACT OF THE DISCLOSURE

An engine control system for maintaining the operator-commanded speed setting of an internal combustion engine over a range of engine loads and for easy starting and improved efficiency over a range of ambient and engine operating temperatures. The engine control system includes a governor assembly driven by the engine, the governor assembly supplying an output to a sensor assembly through a mechanical coupling member operator. The sensor assembly provides an engine speed control signal which corresponds to operator commanded engine speed and actual engine speed. The engine speed control signal is provided to a throttle actuator to control actual engine speed is controlled to correspond with the operator-commanded engine speed regardless of loads imposed on the engine.